SPR-04

Intelligent
Single Point Sensor

USER MANUAL

by LMI Technologies Inc.

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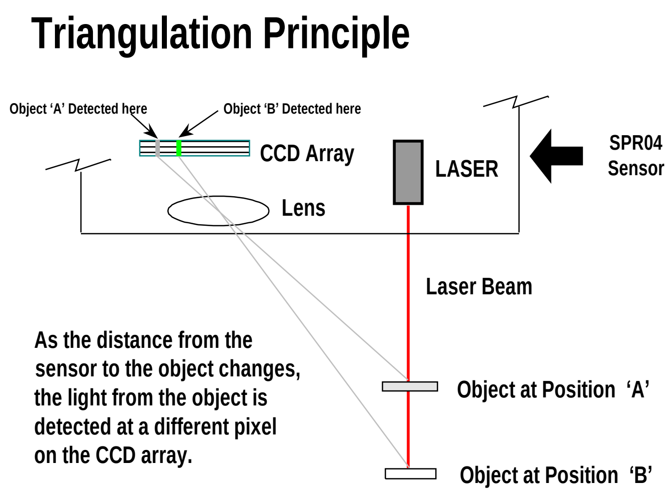
USA:	5,096.922	4375,921	4,305.661	4,373.804	4,875.776
	5,114.230	5,164.579	5,362.970	5,510.625	5,670.787
	5,684.292	5,691.545	5,734.172	4,667.231	4,576.482
	4,394.683	5,811.827	Australia		616.731
Canada	1,307.051	1,116.750	New Zealand		228.128
Germany	30 16 361	31 23 703	Finland		94551

Printed in Canada
Version B

1. Specifications

1.1 Welcome to the SPR-04

The SPR-04 is a member of the DynaVision® family of laser-based ranging sensors from LMI Technologies Inc. These sensors employ a laser and the triangulation principle to make precise measurements of range.



The distance from the face of the sensor to the sensor's zero point is the **Standoff** range. The sensor cannot make any measurements closer than the **Standoff** range. If a target is placed closer than the zero point, the analog output reads zero volts and the digital output will return "Out of Range" indicating out of range.

The distance from the sensor's zero point to the sensor's maximum point (for which it has been calibrated) is the **Range**. In between these two points the sensor will return a valid reading indicating how far the measurement surface is away from the standoff, or zero point.

1.1.1 What is the maximum distance an object can be placed from the sensor's reference point?

The **Standoff** distance plus the **Range** distance is the maximum distance an object can be placed away from the face of the sensor.

Standoff distance + Range distance = Object's Maximum Distance

If the distance to an object is greater than the **Standoff** distance plus the **Range** distance, the sensors analog output will read zero volts and the digital output will return "Out of Range" indicating out of range.

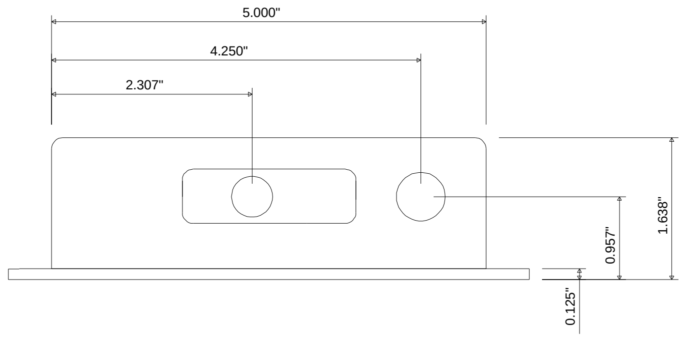
Object Distance > (Standoff + Range) => Out of Range

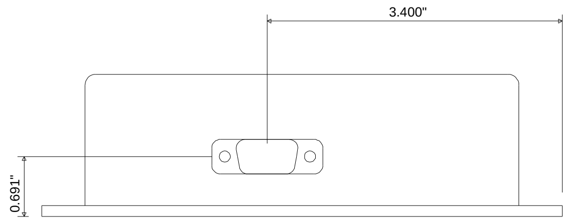
1.1.2 How do laser triangulation sensors work best?

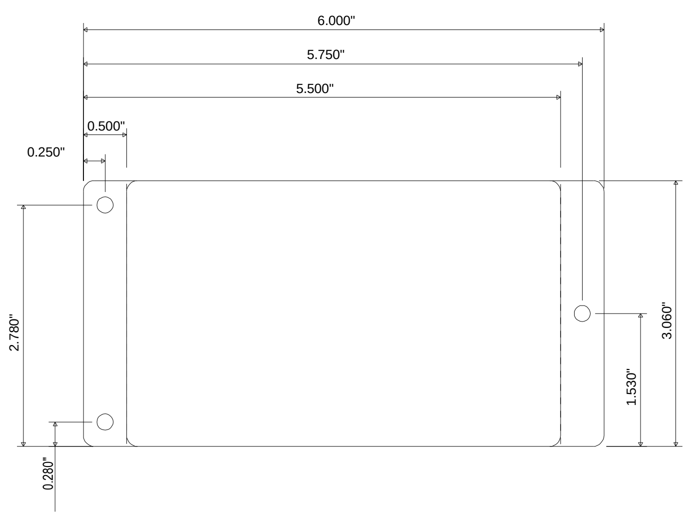
Laser triangulation sensors work best when the measurement surface is a diffuse reflector such as the surface of a piece of paper, wood, or non-shiny metal and plastic.

1.1.3 Mechanical Specifications

Dimensions 6.00" x 3.06" x 1.64"


5.000"
4.250"
2.307"
1.638"
0.957"
0.125"


3.400"
0.691"


6.000"
5.750"
5.500"
0.500"
0.250"
2.780"
0.280"
3.060"
1.530"

Electrical Specifications

Power Supply Voltage	15 VDC - 30 VDC (300mA minimum @ 15VDC)
Analog Output	0 VDC – 10 VDC, 4 - 20mA
Maximum Analog Output Load	5kΩ

1.1.4.1. Environmental Specifications

Ambient Temperature	Operating	min	0° C (32° F)
		max	+50° C (122° F)
	Storage	min	-30° C (-22° F)
		max	+70° C (158° F)
Relative Humidity			95% Maximum Non-Condensing at 40° C (104° F)
Housing			Gasket aluminum enclosure

1.1.4.2. Laser Specifications

	Class IIIb
Laser	Visible
Wave Length	655 nm
Laser Power	< 7 mW

1.1.4.3. Performance Specifications

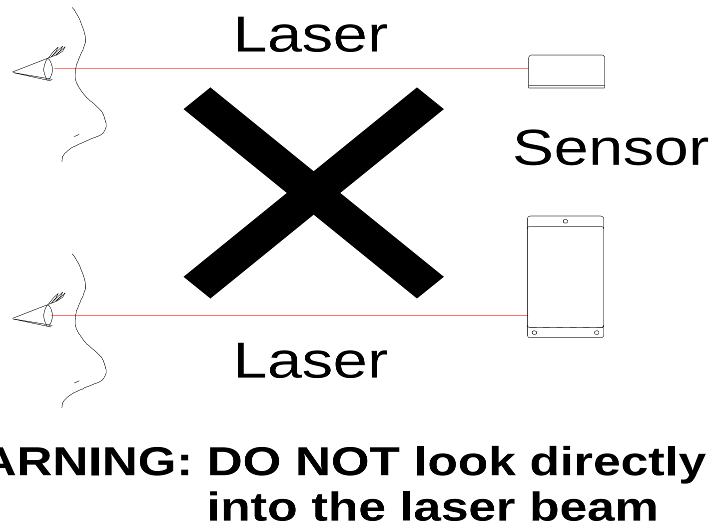
Accuracy	+/- 0.005inches (+/- 0.127mm)
Resolution (Digital):	0.001 inches (0.025mm)
Resolution (Analog):	0.003 inches (0.075mm)
Standoff	2" (50mm for metric)
Max Range	8" (200mm for metric)

1. Laser Safety

Caution! Use of controls or adjustments, or performance of procedures other than those specified herein may result in hazardous radiation exposure.

DynaVision® scanners use lasers to illuminate the measurement surface. This requires that specific safety precautions be taken when working near, or servicing the sensors.

Under the Code of Federal Regulations (CFR) 21, Part 1040, the U.S. Food and Drug Administration (FDA), classifies the SPR-04 sensor as a Class IIIb device. This classification is clearly marked on the SPR-04 sensor.



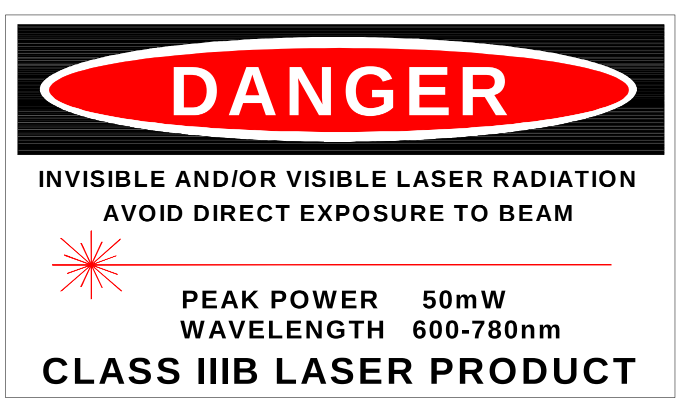
Warning! **The SPR-04 is a Class IIIb laser device.** Regardless of the power rating, or whether or not the laser is visible, the laser should not be viewed directly, or through a mirror, as it may result in damage to the eyes

2.1 OEM Safety Responsibilities

LMI Technologies Inc. has filed a report with the US Food and Drug Administration (FDA) to assist OEM's in achieving certification of their own applications by referencing the report accession number. The following paragraphs outline areas that are not covered by LMI Technologies Inc. submission and need to be specifically addressed by the OEM.

2.1.1 Laser Warning Sign Format

Laser warning signs must be located in the vicinity of the sensors such that they will be readily observed. Refer to the following diagram for an example of the laser warning sign. Different warning signs are required for different laser classifications. These are specified in the CFR Title 21, Section 1040. An example is shown below for a Class IIIb sensor.



2.1.2 Laser Emission Warning Indicators

As specified by the US Food and Drug Administration, Department of Health and Human Services, Code of Federal Regulations 21 Section 1040 (CFR 21-1040), the controls which operate the single point sensors must incorporate a visible or audible signal when the lasers of the sensors are active. Typically this consists of a warning lamp which is illuminated when power is supplied to the sensor.

If the sensors are mounted more than 2 meters from each other, or the controls, it is required that warning indicators be placed at each location. When mounting the warning indicator it is important not to mount it in a location that would require exposure to the laser emissions in order to see it.

Additionally, CFR21-1040 standards require that he indicator be clearly visible through protective eyewear designed specifically for the wavelengths of the emitted laser radiation.

2.1.3 Beam Attenuators

CFR 21-1040 standards specify that a permanently attached method of preventing human access to the laser radiation other than switches, power connectors, or key control must be employed.

2.1.4 Additional Requirements for Class IIIb sensors

All Class III laser sensors must adhere to the items mentioned in the preceding paragraphs. For any systems which incorporate Class IIIb sensors (>5mW or non-visible lasers) the following paragraphs describe additional requirements that must be met.

2.1.5 Power-On Delays

A delay circuit is required for Class IIIb laser systems which illuminates the warning indicators, or sounds the audible alarms for a short period of time prior to supplying power to the lasers. The length of the delay should provide enough time to for personnel to take the appropriate action to avoid exposure to the lasers.

2.1.6 Key Lock Switch

The controls must have a key lock switch, which when in the OFF position prevents any power from being supplied to the lasers. Additionally, the switch must not allow the key to be removed from the lock while in the ON position.

2.1.7 Remote Interlock Connector

A remote interlock connection that allows remote switches to be attached "in series" with the key lock switch on the controls must be present. The deactivation of any remote switches must prevent power from being supplied to the lasers.

None of the items mentioned above are supplied with the SPR-04 and are the responsibility of the OEM to supply when incorporating the SPR-04 into their system or product.

3. Introduction

3.1 How can the SPR-04 be used?

The SPR-04 can be used in a wide variety of measurement applications, including:

- Object profiling
- Thickness measurement
- Parts inspection
- Object alignment
- Range measurement

The SPR-04 is a 'smart' sensor incorporating an internal processor to handle calibration, scaling and data conversion. The SPR-04 provides two analog output (0-10 VDC and 4-20mA) and digital serial output (RS-485).

3.1.1 Do I need a computer to use the SPR-04?

An SPR-04 with the digital interface can be used with or without a computer control system.

Without a computer The SPR-04 can be employed as an analog sensor and does not require connection to an external computer. Connect the cable to:

- A suitable power supply
- A voltage measurement device

With a computer The SPR-04 can be used in a computer-based data acquisition or control system. Commands requesting data are sent to the sensor and the sensor responds by providing range values. Commands and data are exchanged with the SPR-04 using a simple serial protocol (see Communications Protocol). To operate the sensor:

3.2 UNPACKING

Upon receipt, unpack and visually inspect the sensor. The sensor is a single metal enclosure with a connector on one side, and with laser and sensor viewing window on the opposite side. Ensure there is no damage to the enclosure, connector or view windows.

The enclosed diskette contains:

SPR-04 Utility Program (SPUTIL.EXE)

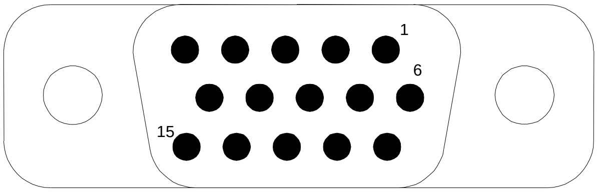
3.3 GETTING STARTED

3.3.1 Necessary Equipment

You will need:

- a DC power supply
- an instrument capable of measuring zero (0) to ten (10) volts DC
- a flat surface
- Windows 98 or Windows XP (if you are using the sensor with a computer)
- an RS-232 to RS-485 converter

3.3.2 Connector Pin out (As viewed from the sensor)



Pin #1, 15	Power In (15 – 30VDC)
Pin #2	Receive (-)
Pin #3	Transmit (-)
Pin #4	Analog Out 0 – 10VDC
Pin #5	Out of Range Indicator
Pin #6	NC
Pin #7	NC
Pin #8	Analog Common
Pin #9	Receive (+)
Pin #10	Transmit (+)
Pin #11	Power Common
Pin #12	Analog out 4-20mA
Pin #13	OUT2B
Pin #14	NC

3.3.3 Operating your SPR-04 sensor is quite simple.

You can use it in two ways

- As a stand-alone device requiring only a DC power supply and an instrument capable of measuring zero (0) to ten (10) volts DC.
- Sensors with the optional digital serial interface can be connected to a personal computer through the serial communication port.

1. Place the sensor onto a table or flat surface. Be sure that the pathway between the laser window (the round hole) and the camera (the elongated window) is not obstructed.

2. Connect the enclosed cable to:
   - a suitable power supply
   - a voltage measurement device (e.g. a DVM)
   - Be sure that the power is OFF on the supply powering the SPR-04, then connect the cable to the back of the SPR-04

3. Turn on your voltage measurement device.

4. If you are using a computer connect the enclosed cable to the serial port of the computer

   The SPR-04 can be connected to both a computer and a voltage-measuring device at the same time.

5. Do not look directly into the laser output window nor point it in the direction of another person (see Laser Safety).

6. Place a suitable target (e.g. a cardboard box or wood block) within the measurement range of the SPR-04

7. Turn on the power supply to the SPR-04. The SPR-04 does not have a power switch so turning on the power supply will activate the SPR-04.

8. If you are using a computer start the SPUtil.EXE application.
Set the software to use the correct communication port (See SPR-04 setup utility). Click on "View " to open the range and spot information dialog. Click on "Start."

9. You should now see a voltage reading on the voltage measurement device, and/or a display of the range readings on the computer screen.

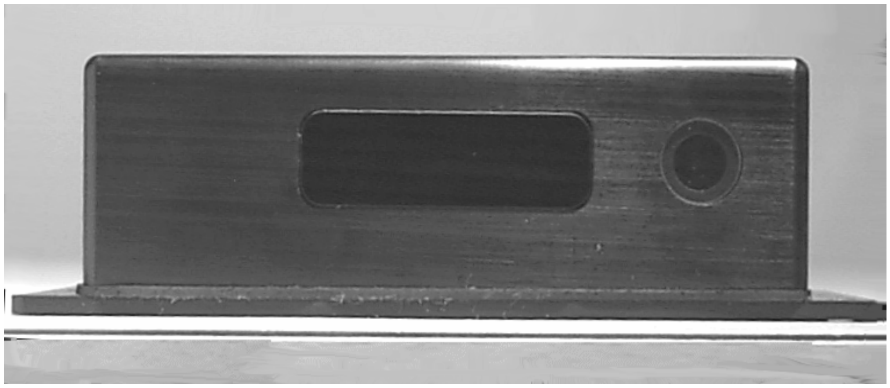
You are now ready to employ the SPR-04 in a wide variety of applications.

3.4. Mechanical Mounting

The accuracy of the sensor is dependent on a secure mechanical mounting. Any movement or vibration of the sensor relative to the object being measured will result in measurement errors. The sensor enclosure contains a mounting plate with three pre-drilled mounting holes (See Figure Below).

Calibration of the SPR-04 is relative to the reference face of the sensor. The minimum distance the target can be from the reference face of the sensor is the standoff distance.

The surface the sensor is mounted to must be flat within 0.030” (0.76mm) between the three mounting points. This can be accomplished with 0.125” (3.16mm) standoff washers between the mounting surface and the sensor.



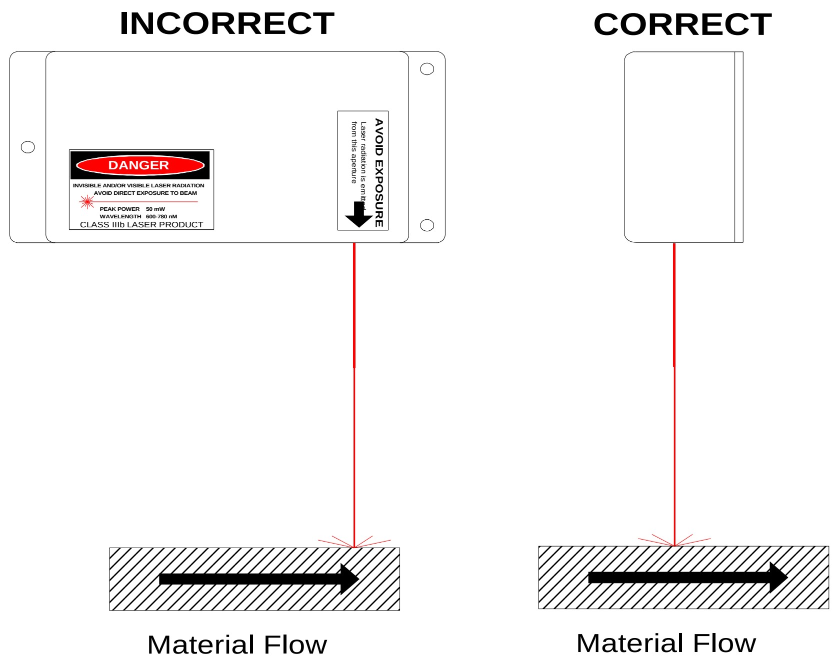
To ensure that the sensor does not report a false reading, it is recommended that a baffle plate be used.

A baffle plate is a solid plate located outside the sensor's measurement range, directly in the sensor's field of view. There needs to be a 3/8" hole drilled in the plate to allow the laser light to pass through. When there is no target in the measurement range of the sensor the baffle plate will block the sensor's camera from seeing the laser light. Therefore guaranteeing a fast response to the target coming into range and going out of range.

3.5. Sensor Orientation

The sensor should be mounted so the beam is projected perpendicular to the surface.

The surface directly below the sensor should be non-reflective. If material is to move past the sensor, the sensor should be mounted so that the movement of the material intersects the line between the laser and the camera.



4. Serial Communications

4.1 General Overview

All communication between the host computer and the sensor is via an RS-485 serial interface.

All commands are initiated from the host computer to the sensor, with the sensor responding to the commands.

4.2 Communications Specifications

The SPR-04 uses the RS-422/485 standard for its serial communication. This is a differential driver/receiver pair. It is capable of transmitting up to 4000 feet.

The serial ports of most personal computers are based on the two-wire RS-232 standard. To use a personal computer as the host for a multi-drop configuration, you will need an RS-232 to RS-485 converter box.

The RS-485 option allows the sensor to be used in multi-drop configurations. This means that up to 32 units can be connected to the same serial line. Each device must have a different address so that you are able to distinguish which unit you are talking to. The utility SPUtil.EXE is supplied to allow you to set the address of each SPR-04 unit. This program only works in Microsoft Windows® environments.

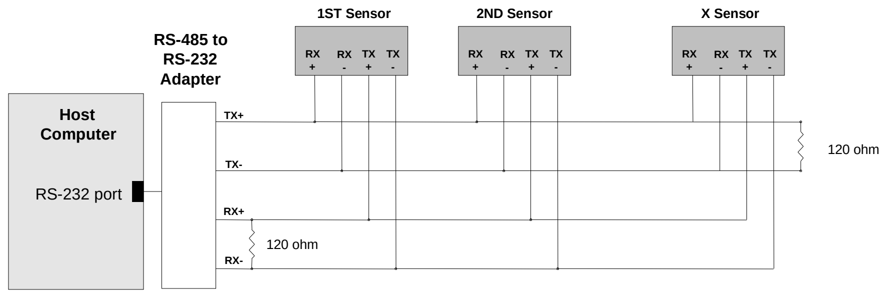
4.3 Serial Specification

Transmit and Receive lines are connected to the serial I/O port of a host computer. This serial I/O port must be configured as follows:

- Asynchronous
- 9600 - 57600 baud.
- 8 Data Bits
- One Stop Bit
- No Parity

4.4 Serial Connections Multi-Drop Configurations

SPR-04 sensors can be wired in a multi-drop configuration. The serial communication must be wired as full duplex; meaning four wires are required to complete the hardware connection as illustrated in the figure below:



Up to 32 SPR-04 sensors can multi-dropped as shown.

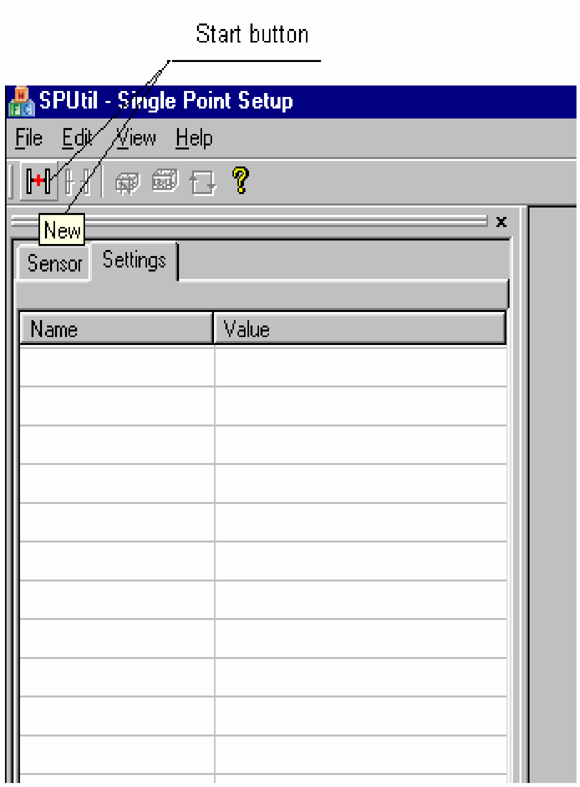
- Tx+ of all the SPR-04 sensors are connected to the Rx+ of the Host
- Tx- of all the SPR-04 sensors are connected to the Rx- of the Host
- Rx+ of all the SPR-04 sensors are connected to the Tx+ of the Host
- Rx- of all the SPR-04 sensors are connected to the Tx- of the Host

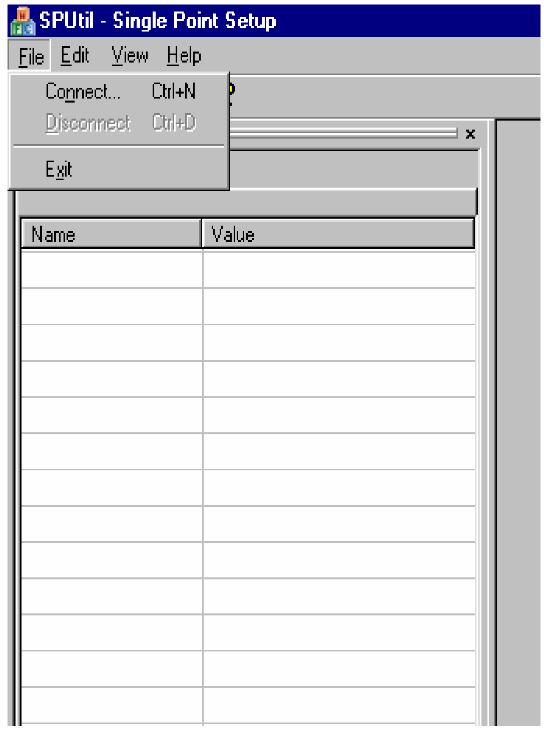
A 120 ohm termination resistor must be connected across the Tx+ and Tx- at the end farthest away from the host computer, and the Rx+ and Rx- nearest the host computer.

4.5 Using SP Setup Utility

4.5.1. Connecting to the Sensor

Start the SPUtil.exe software: click on the “New” button or select the File” Connect” option.

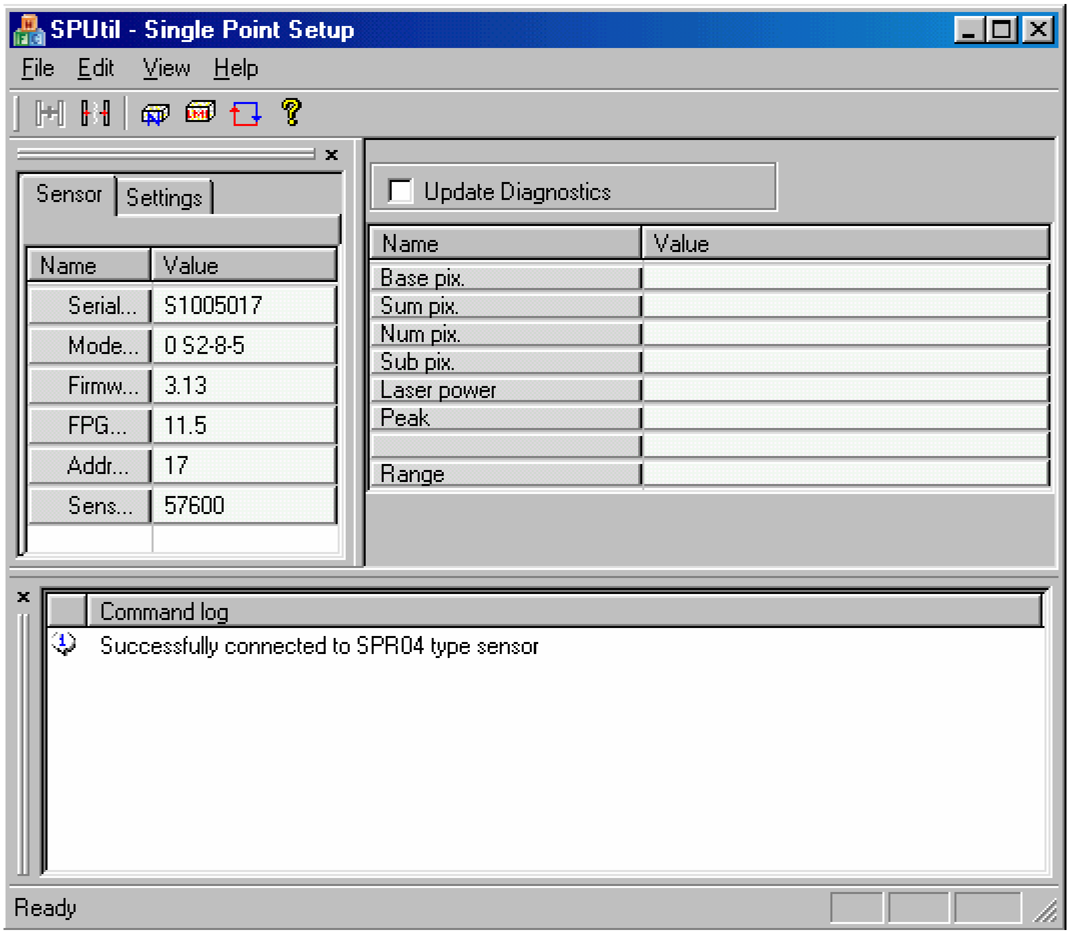




Select the proper COM Port, Baud Rate (57600 - Factory Default Rate), the unit address and click on “**OK”** button. If the unit address is not known, check the” **Use global address”** option.

NOTE : Do not use **”Use global address”** option in multi-drop configuration. All sensors have default address of 1. In case of multi-drop configuration, ensure that each sensor has been assigned a unique address before being placed on single communication line.

4.5.2. Connecting Successfully to the SPR-04 Sensor



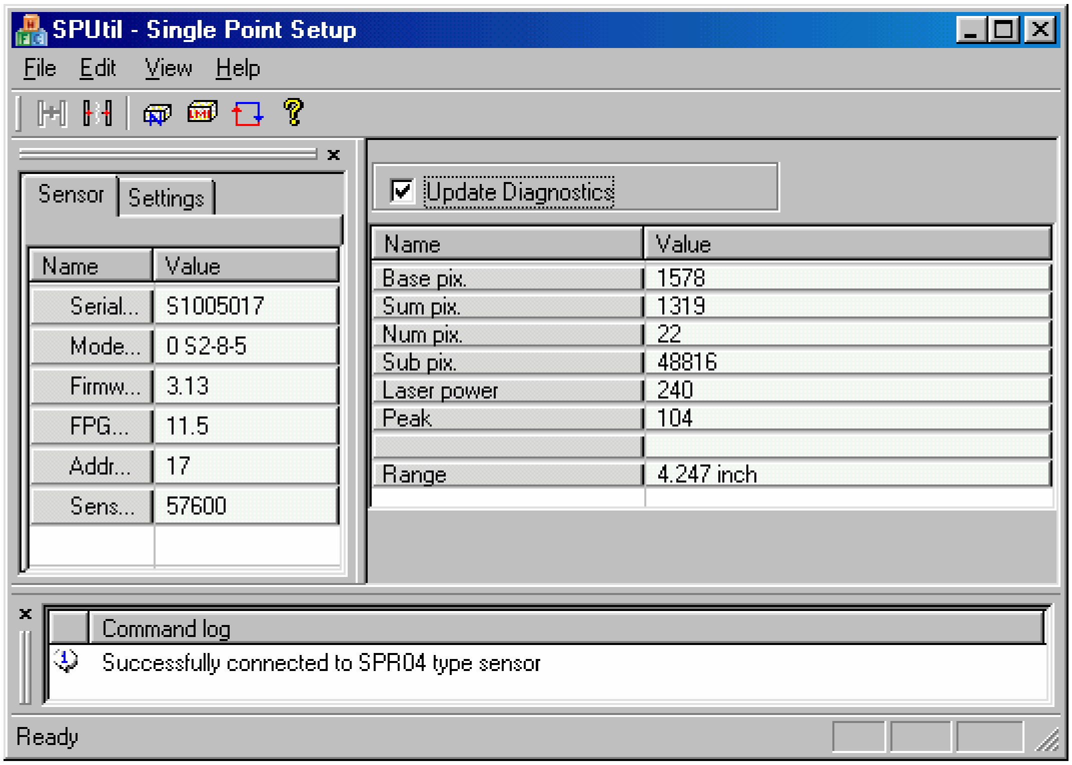
Serial #. The number shown here is the sensor's serial number which is labeled on the side of the sensor enclosure (Factory Programmed).

Firmware This is the firmware version of the sensor (Factory Programmed).

Model # This is the sensor's model number (Factory Programmed).

FPGA This is the sensor's FPGA version of the sensor (Factory Programmed).

4.5.3. Changing Sensor Parameters



Address

The sensor address may range from 1 to 255, the maximum number of sensors that can be placed on a multi-drop line. Each sensor must have a different address.

To change the address of the sensor, enter new address and click on “Address” button.

Note: When changing the address, only one sensor must be communicating with the host.

Baud Rate

This is the sensor’s Baud Rate that it uses to communicate to the Host. To change Baud Rate select the Baud Rate from the list and click on “Baud Rate” button. The Baud rate is preset at the factory to 57600 Baud.

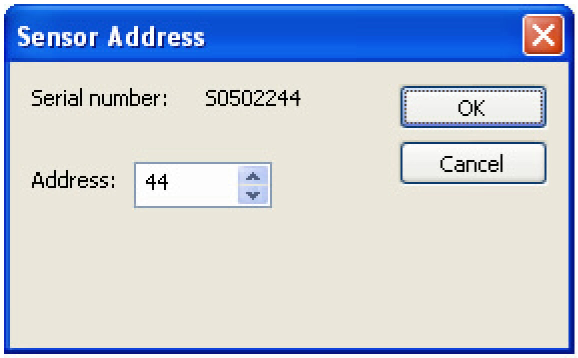
Error Checking

Error checking method used by sensor to communicate with the Host:
Checksum (Default) or CRC.
To change select the method from the list and click on “Error Checking” button.

Set to Defaults

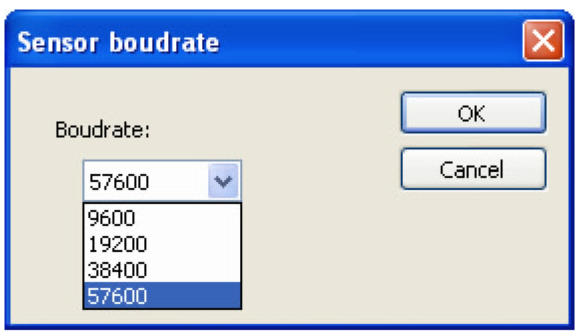
Sets all sensor parameters to factory defaults.

Sensor Address The sensor address may range from 1 to 255, the maximum number of sensors that can be placed on a single multi drop line. Each sensor must have a different address. To change the address of the sensor, double click on the current address. New window will appeared, enter new address and click on "OK" button.



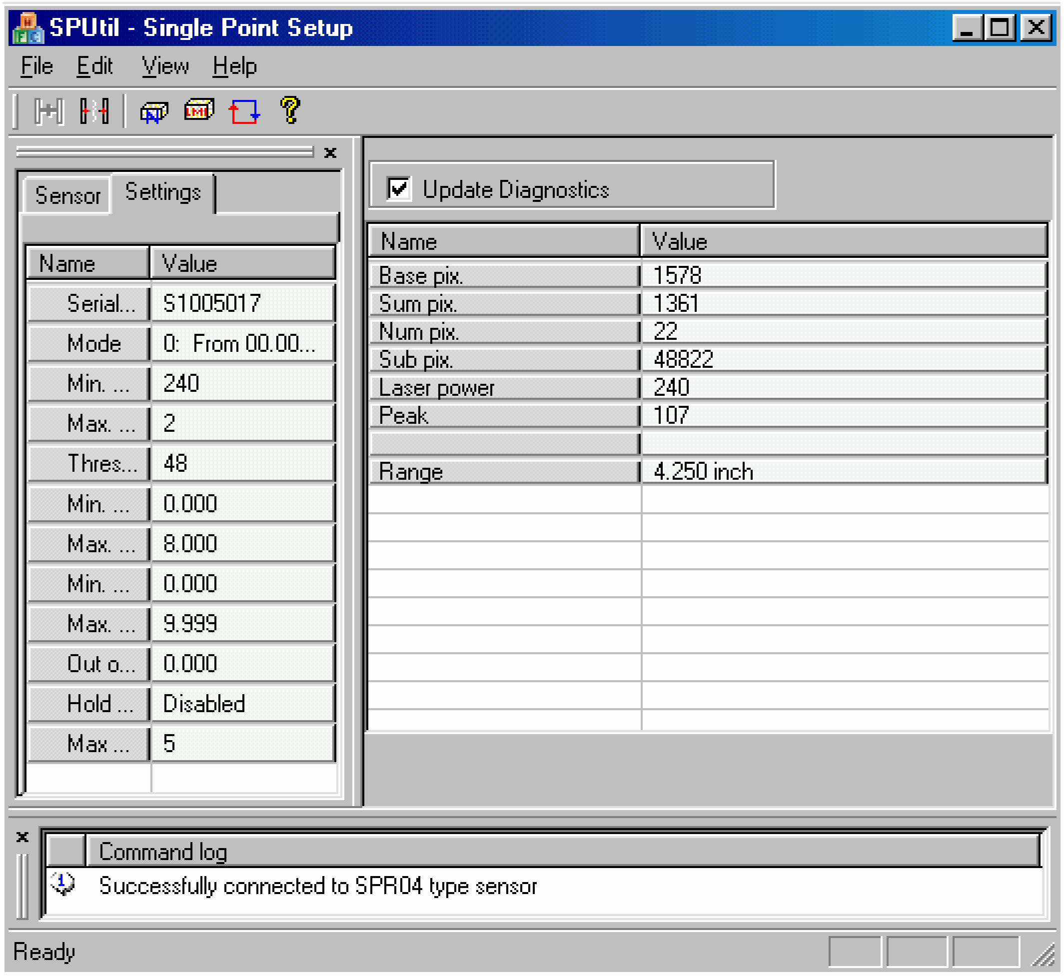
Note: When changing the address, only one sensor must be communicating with the host.

Baud Rate This is the sensor's Baud Rate that it uses to communicate to the Host. To change Baud Rate of the sensor, double click on the current Baud Rate. New window will appeared select the Baud Rate from the list and click on "OK" button. The available rates are 9600, 19200, 39400, and 57600.



The factory default Baud Rate is 57600.

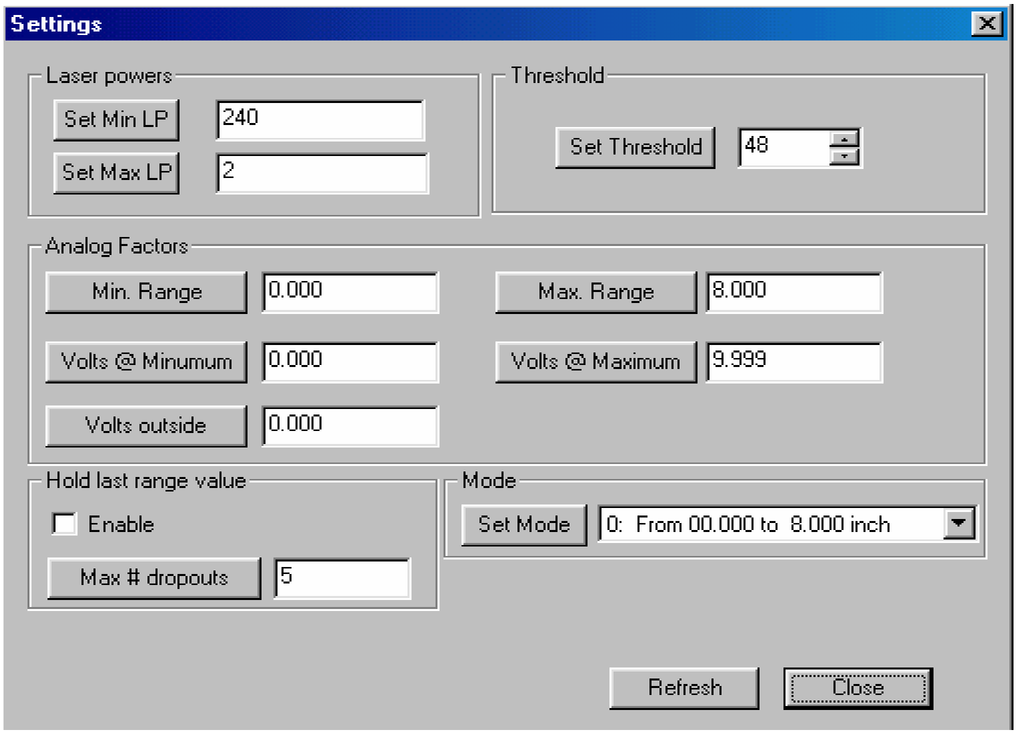
4.5.4. Sensor Settings/Diagnostic



Settings In the "Settings" window all sensor settings can be changed accordingly. Double click on any setting will open SPR04 Settings display.

Max Laser Power During automatic laser power adjustment, this limits the maximum power. The power can be adjusted from 1-254: the lower the value, the higher the laser power. Together with "Min Laser Power" you can setup the Laser Power range in which the sensor will operate. To change the maximum laser power, enter the new power setting and click on "Max Laser Power". The recommended value for Max Laser Power is 2.

Min Laser Power During automatic laser power adjustment, this limits the minumum power. The power can be adjusted from 1-254: the higher the value, the lower the laser power. Together with "Max Laser Power" you can setup the Laser Power range in which the sensor will operate. To change the minimum laser power, enter the new power setting and click on "Min Laser Power". The recommended value for Min Laser Power is 240.



Threshold This refers to the A to D converted threshold for detecting the laser spot and filtering it through the background light. The threshold can be adjusted from 0-255. The lower the value the more sensitive camera becomes to laser light but also becomes more sensitive to background ambient light. Recommended value for threshold is 48.

Min Range Sets the sensor's range at which the analog output is at the "volt@min". For any range less than this value, sensor will output the analog reading of "**volt @ OutOfRange**" and digital reading "Out of Range".

Max Range Sets the sensor's range at which the analog output is at the "volt at max". For any range greater than this value, sensor will output the analog reading of "**volt @ OutOfRange**" and digital reading "Out of Range".

Volt @ Min Analog output when the object sensed is at the nearest point ("**Min Range**") of the sensor's range.

Volt @ Max Analog output when the object sensed is at the furthest point ("**Max Range**") of the sensor's range.

Volt @ Out Of Range Voltage output when the object sensed is outside the defined "min range" and "max range".

Hold Last Valid Range

Max # of Dropouts

In case of an out of range reading, the sensor can be setup to output last valid range value for the next five (5) samples. This is best used to prevent detection of short dropouts or holes when measuring continuous material. It should NOT be used when trailing edge detection is required on objects that appear and disappear from view. To change the option check/uncheck the “Hold Last Valid Range for ” and then click on “Enable” button (next to it).

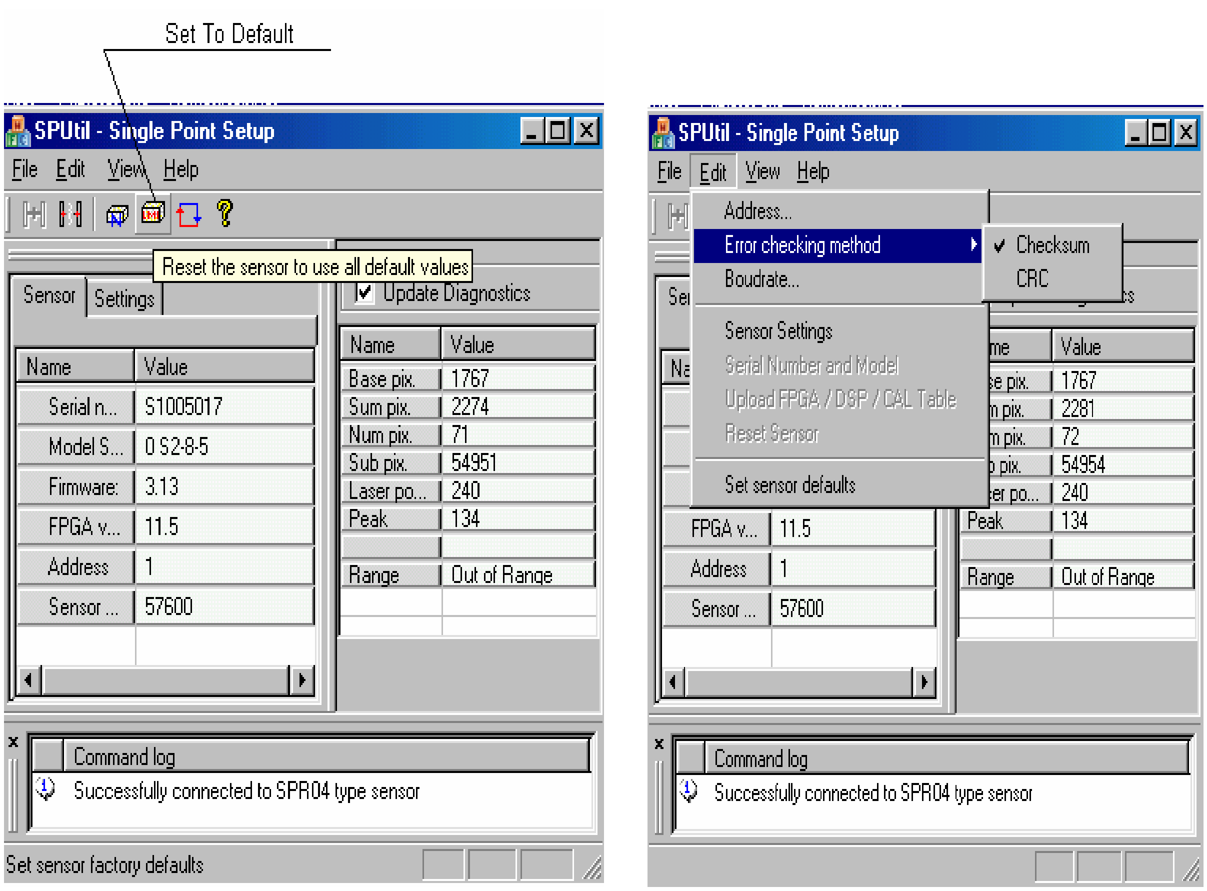
Metric

Changes the sensor mode from Metric to Imperial or Imperial to Metric:
To change select the mode from the list and click on “ Mode ” button to put sensor into new mode.

Note: When changing sensor’s mode from metric to imperial or vice versa, recheck the sensor’s min/max range setting.

Set Sensor to Defaults

Sets all sensor parameters to defaults:
- use Default button
- use Edit/Set sensor defaults option

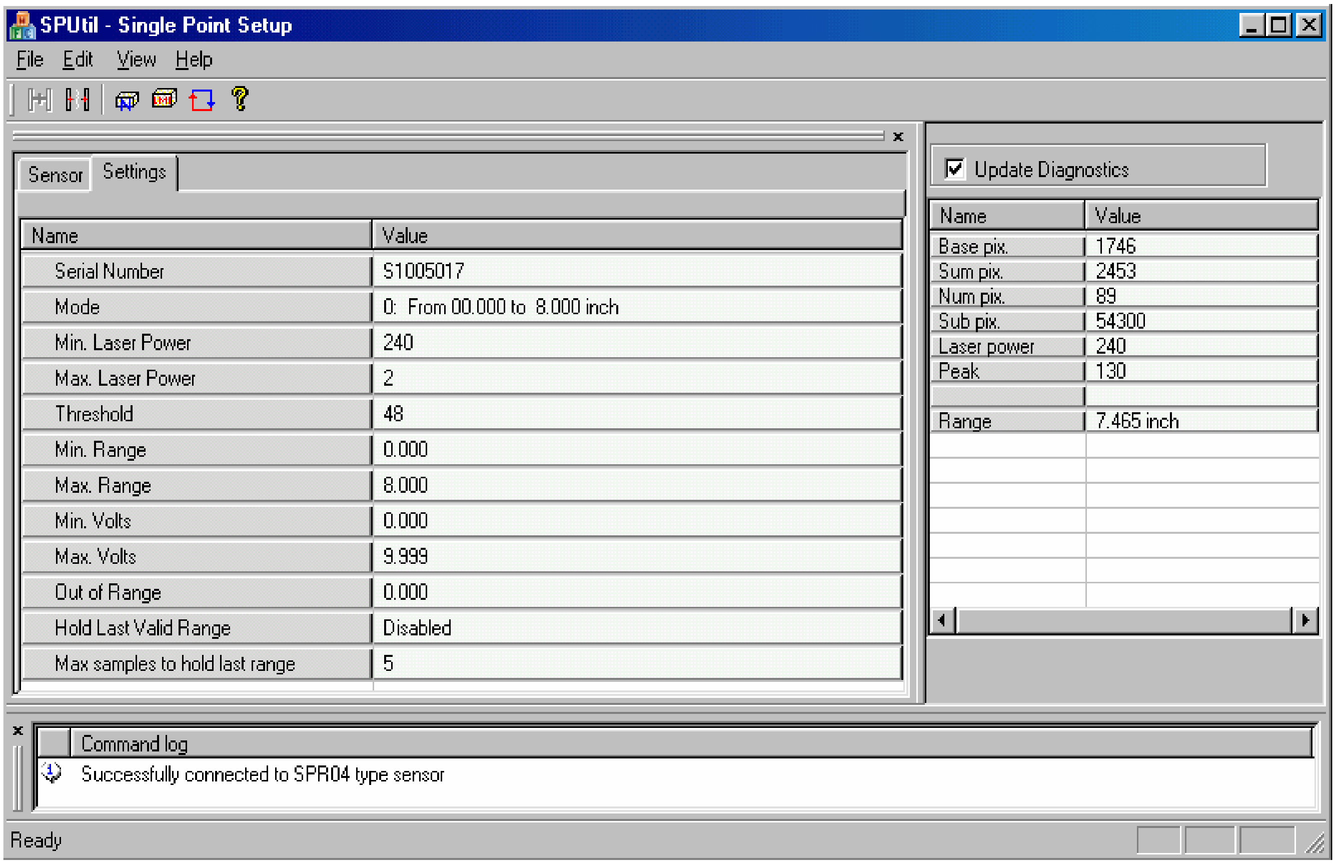


Error Checking

Error checking method used by sensor to communicate with the Host:
Checksum (default) or CRC.
To change select the method from the “Edit”/ ”Error checking method”.

View Ranges/
Spot Info

Allows user to view range and spot information continuously.



Click on the "Update Diagnostics" window to continuously display spot Information

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5. Communications Protocol

This section describes the contents of the packet used to transmit commands and data between a host computer and an SPR-04 sensor.

5.1 General Packet Protocol

An asynchronous RS-485 serial communication link serves as the hardware interface between the host and the sensor(s). The software protocol describes the packet or group of information that is transmitted. This consists of:

- an address
- a command
- data (optional)
- a checksum /CRC

5.2 Packet Description

A packet consists of a string of bytes. The same format is used to transmit from the host to the sensor and back.

PACKET FORMAT **[STX] [Address] [Length] [Command] [Data..Data] [Checksum] or [CRC]**

[STX]	1 byte	Start transmission character (02 hex)
[Address]	1 byte	0 broadcast to all sensor addresses. 1..255 addressing a specific sensor. **Note:** This byte identifies the sender when received by the host.
[Length]	1 byte	When using Checksum for error checking this is the number of data bytes from command to the last Data byte (not including the Checksum). Maximum 255. When using CRC for error checking this is the number of data bytes only.
[Command]	1 byte	1..255 See command descriptions.
[Data..Data]	'n' bytes	Number of bytes depend on the command.
[Checksum]	1 byte	2's Complement sum of all bytes inclusive of STX and last data byte.
OR		
[CRC]	2 byte	16 bit CRC of all bytes inclusive of STX and last data byte

5.3 PACKET EXAMPLE:

To request the current range value from the sensor, the host computer program should send the following message packet:

If using Checksum

02	Address	1	12	Checksum (1Byte)
STX Character	Device Address	Command Size	Command (read)	

If using CRC

02	Address	0	12	CRC (2 Bytes)
STX Character	Device Address	Command Size	Command (read)	

Numeric Formats

The following describes the format of numbers contained within a packet.

Byte always an unsigned 8 bit number 0..255.

Words All words used in commands data streams are signed 16 bit numbers.
When using CRC,MSB of the data word is send first
When using Checksum LSB of the data word is sent first.

Decimal points are assumed depending on data content. For example:

If the data is expected in inches then 1234 would represent 1.234". If the data is expected in millimeters then 1234 would represent 12.34 mm

5.5 Serial Communication Commands

Command	**12**	**GET_RANGE**

Purpose Returns the current range reading.

Command Format **[Command]**

Command	(1 Byte)	12

Response Format **[Command] [Range]**

Command	(1 Byte)	12
Range	(1 Word)	

Command	**18**	**SET SERIAL ADDRESS OF THE SENSOR**

Purpose Assigns a specific address to the sensor identified by the serial number. This command can be broadcasted to all sensors (packet Adders is zero). Each sensor checks the [serial#] and if it matches the serial # stamped on the face if the sensor, the [address] is set. This address is then used to send commands to a specific sensor.

Command Format **[Command] [Serial# (8 Bytes)] [Address]**

Response Format **if using CRC :** **[Command]**

Command	(Byte)	18	Succes
		0	Fail

If using ChkSum : None

Command	**132**	**GET SERIAL ADDRESS OF THE SENSOR**

Purpose Read the sensor's serial address

Command Format: **[command]**

Response Format: **[command] [Address]**

Command	(1 Byte)	132
Address	(1 Byte)	

Command 67 SET_HOLD_SAMPLES

Purpose Set sensor to output last valid (in-Range) reading.

Command Format **[Command]**

Command	(1 Byte)	67

Response Format

if using CRC : **[Command]**

Command	(Byte)	67	Success
		0	Fail

If using ChkSum : None

Command 68 GET_HOLD_SAMPLES

Purpose Returns HOLD_SAMPLES value

Command Format **[Command]**

Command	(1 Byte)	68

Response Format **[command] [hold_samples]**

Command	(1 Byte)	68
Samples	(1 Word)	

Command 36 SET_SENSOR_MODE

Purpose Returns the current reading in inches or metric depending on the sensor mode with offset added .

Command Format **[Command]**

Command	(1 Byte)	36

Response Format **[Command] [position]**

Command	(1 Byte)	36
Position	(1 Word)	±(sensor range)

Command 92 SET BAUD RATE OF THE SENSOR

Purpose
To put sensors to specific baud to match the RS-485 serial input and output ports baud rate.

Command Format:
[command] [Baud]

Command	(1Byte)	92
Baud	(1Byte)	(0 : 9600, 1 : 19200, 2 : 38400, 3 : 57600)

Response Format
if using CRC : **[Command]**

Command	(Byte)	92	Success
		0	Fail

If using ChkSum : None

Command 135 GET BAUD RATE OF THE SENSOR

Response
Read Sensors Baud setting

Response Format:
[command] [Baud]

Command	(1 Byte)	135
Baud	(1 Byte)	

Command 77 SET ERROR CHENGING TO CRC / CHECKSUM

Purpose
Change sensor’s error-check from CRC to Checksum or vice-versa..

Command Format:
[command][Mode]

Command	(1 Byte)	77
Mode	(1 Byte)	0 : CRC / 1 : Chksum

Response Format
if using CRC : **[Command]**

Command	(Byte)	77	Success
		0	Fail

If using ChkSum : None

Command 66 SET TO DEFAULTS

Purpose: Sets all sensor parameters to Factory Defaults.

Command Format: **[command]**

Command	(1 Byte)	66

Response Format **if using CRC :** **[Command]**

Command	(Byte)	66	Success
		0	Fail

If using ChkSum : None

Command 93 WRITE MINIMUM ANALOG RANGE

Purpose Sets sensor's minimum range; for targets closer than this range, sensor will output Out of range value($FFFF).

Command Format: **[command][Min Range]**

Command	(1 Byte)	93
Min. Range	(1 Word)	(0 . . 12000)

Response Format **if using CRC :** **[Command]**

Command	(Byte)	93	Success
		0	Fail

If using ChkSum : None

Command 140 GET MINIMUM ANALOG RANGE

Purpose Returns the sensor's minimum range

Command Format **[Command]**

Command	(1Byte)	140

Response Format **[Command] [Min. Range]**

Command	(1 Byte)	140
Min. Range	(1 Word)	

Command 94 WRITE MAXIMUM ANALOG RANGE

Purpose

Sets sensor's maximum range; for targets further than this range, sensor will output Out of range value($FFFF).

Command Format:

[command][Mode]

Command	(1 Byte)	94
Max. Range	(1 Word)	(0 .. 12000)

Response Format

if using CRC : [Command]

Command	(Byte)	94	Success
		0	Fail

If using ChkSum : None

Command 141 GET MAXIMUM ANALOG RANGE

Purpose

Returns the sensor's maximum range

Command Format

[Command]

Command	(1 Byte)	141

Response Format

[Command] [Max. Range]

Command	(1 Byte)	141
Max. Range	(1 Word)	

Command 90 WRITE MINIMUM ANALOG VALUE

Purpose

Sets the minimum voltage settings. This is the output when target is detected at the closest point (MIN. Range).

Command Format:

[command][Min_Da_Out]

Command	(1 Byte)	90
Min_Da_Out	(1 Word)	(0 . . 9999)

Response Format

if using CRC : [Command]

Command	(Byte)	90	Success
		0	Fail

If using ChkSum : None

Command 142 GET MINIMUM ANALOG VALUE

Purpose Returns the minimum voltage setting

Command Format **[Command]**

Command	(1 Byte)	142

Response Format **[Command] [Min DAOut]**

Command	(1 Byte)	142
Min_Da_Out	(1 Word)	

Command 91 WRITE MAXIMUM ANALOG VALUE

Purpose Sets the maximum voltage settings. This is the output when target is detected at the Farthest point (MAX. Range).

Command Format: **[command][Max_Da_Out]**

Command	(1 Byte)	91
Max_Da_Out	(1 Word)	(0 . . 9999)

Response Format **if using CRC :** **[Command]**

Command	(Byte)	91	Success
		0	Fail

If using ChkSum : None

Command 143 GET MAXIMUM ANALOG VALUE

Purpose Returns the maximum voltage setting

Command Format **[Command]**

Command	(1 Byte)	143

Response Format **[Command] [Max DAOut]**

Command	(1 Byte)	143
Max_Da_Out	(1 Word)	

Command 146 WRITE OUT_OF_RANGE ANALOG VALUE

Purpose

Sets the Out_Of_Range analog value for the sensor. This is the value that sensor outputs when target is out of the sensor's range

.

Command Format: **[command][OutR_Da_Range]**

Command	(1 Byte)	146
OutR_Da_Out	(1 Word)	(0 . . 9999)

Response Format **if using CRC : [Command]**

Command	(Byte)	146	Success
		0	Fail

If using ChkSum : None

Command 145 GET OUT_OF_RANGE ANALOG VALUE

Purpose

Returns Out_Of_Range analog value

Command Format **[Command]**

Command	(1 Byte)	145

Response Format **[Command] [OutR_Da_Out]**

Command	(1 Byte)	145
OutR_Da_Out	(1 Word)	

Command 84 WRITE MINIMUM LASER POWER

Purpose

Sets the minimum laser power (This is actually the OFF time of the laser power PWM; so higher the value , lower the laser power.)

Command Format: **[command][Min_Power]**

Command	(1 Byte)	84
Min_Power	(1 Byte)	(1. . 254)

Response Format **if using CRC : [Command]**

Command	(Byte)	84	Success
		0	Fail

If using ChkSum : None

Command 130 GET MINIMUM LASER POWER

Purpose Returns the minimum laser power setting.

Command Format **[Command]**

Command	(1 Byte)	130

Response Format **[Command] [Min. Power]**

Command	(1 Byte)	130
Min. Power	(1 Byte)	

Command 83 WRITE MAXIMUM LASER POWER

Purpose Sets the maximum laser power (This is actually the OFF time of the laser power PWM; so lower the value , higher the laser power.)

Command Format: **[command][Max_Power]**

Command	(1 Byte)	83
Max_Power	(1 Byte)	(1 . . 254)

Response Format **if using CRC :** **[Command]**

Command	(Byte)	83	Success
		0	Fail

If using ChkSum : None

Command 129 GET MAXIMUM LASER POWER

Purpose Returns the maximum laser power setting.

Command Format **[Command]**

Command	(1 Byte)	129

Response Format **[Command] [Max. Power]**

Command	(1 Byte)	129
Max_Power	(1 Byte)	

Command 82 WRITE THRESHOLD

Purpose

This refers to the A to D converted threshold for detecting the laser spot and filtering it, lower the value the more sensitive camera becomes.

Command Format:

[command][Threshold]

Command	(1 Byte)	82
Threshold	(1 Byte)	(0 . . 255)

Response Format

if using CRC : [Command]

Command	(Byte)	82	Success
		0	Fail

If using ChkSum : None

Command 131 GET THRESHOLD

Purpose

Returns the threshold value.

Command Format

[Command]

Command	(1 Byte)	131

Response Format

[Command] [Threshold]

Command	(1 Byte)	131
Threshold	(1 Byte)	

Command 134 START STREAMING

Purpose Puts the senor to streaming data mode.

Command Format: **[command]**

Command	(1 Byte)	134

Command 147 END STREAMING

Purpose Stop the sensor from streaming data mode.

Command Format: **[command]**

Command	(1 Byte)	147

Command 21 GET SPOT

Purpose Returns a variety of values in relation to current spot

Command Format **[Command]**

Command	(1 Byte)	21

Response Format **[Command] [Data . . Data]**

Command	(1 Byte)	21
BasePix	(1 Word)	
SumPixel	(1 Word)	
NumPixel	(1 Word)	
SubPix	(1 Word)	
Range	(1 Word)	

5.5.1 Command Summary

Command	Description
12	Current Position
18	Set Sensor's Serial Address
21	Read Laser Spot data
36	Sets Sensor Mode(imperial or metric)
66	Sets To Defaults
67	Sets to hold last valid reading
68	Get last valid reading
77	CRC / CheckSum mode
82	Write Threshold
83	Set Maximum Laser Power
84	Set Minimum Laser Power
90	Set Minimum Analog Output value
91	Set Maximum Analog Output value
92	Set Sensor's Baud Rate
93	Set Minimum Sensor Range
94	Set Maximum Sensor Range
129	Get Maximum Laser Power
130	Get Minimum Laser Power
131	Get Threshold
132	Get sensor's serial Address
134	Start Streaming
135	Get Baud Rate of the sensor
140	Get Minimum Sensor Analog Range
141	Get Maximum Sensor Analog Range
142	Get Minimum Analog Output value
143	Get Maximum Analog Output value
145	Get OutofRange Analog Output
146	Set OutofRange Analog Output
147	End Streaming

5.6 Communications Error Handling

The validity of the data in all packets transmitted to and from the sensor is checked using the last byte of the packet as a Checksum or CRC.

5.6.1 How do I process a received data packet?

When receiving a data packet from the sensor, the host application should verify the validity of the data in the packet using the Checksum or CRC byte. Additionally, the application should ensure that the command value returned matches the one sent in the request packet sent to the sensor.

5.6.2 What is the structure of a command packet?

Each command has the same structure as a data packet (see Packet Example). This means you must terminate each command packet with a Checksum or CRC.

5.6.3 What if the sensor detects an error?

If the sensor detects an error in the transmission it will ignore the command and not respond. If there is no response from the sensor within 200 ms then the host application should assume an error occurred and retransmit the original command.

5.7 Packet Timing

Transmissions of packets are initiated by the "STX" (Start of Transmission) character.

Upon receipt of an "STX" character, the sensor will allow a maximum of 50 ms for the next byte to be transmitted by the host.

5.7.1 What if transmission time between 2 bytes exceeds 50 ms?

The sensor will abort receiving the packet and start looking for another STX character.

Upon receipt of an STX character the host should allow an maximum of 200 ms for the complete response to be transmitted from the sensor.

5.7.2 What if the complete packet is not received in 200 ms?

The host application should abort the command and start liking for another STX character.

5.7.3 How do I make sure the host and sensor are synchronized?

To guarantee resynchronization of all sensors on a serial line, the host application should stop all transmissions for 200 ms. After this time, all sensors on the serial line will be waiting to receive an STX character.

6. Application Program Development

Development of application programs for the SPR-04 is a simple task.

Requirements are:

- a suitable serial interface driver
- a program that reads requests and receives character data (byte stream) using the Packet Format described in the previous paragraphs

By writing an application in the host computer, you can:

- request data from the sensor
- read and process data values returned from the sensor

The Pseudo Code below describes a simple application program for use with a single sensor only. In a multi-drop configuration the 'broadcast' address of 0 cannot be used because all sensors would respond simultaneously to the host, preventing the host from receiving a reliable response.

6.1 Pseudo Code

MainLoop

```
// We'll talk to any attached sensor so we 'broadcast' to sensor address 0//
// We want to read the range.  Which is a command value of 12, and length 1//

WHILE (NOT Finished)                    // Until we're told to stop//
        SendSensorCmd(0, 1, 12)         // Send the sensor our request//
        ReadSensorRange                 // Read what the sensor sent//
ENDWHILE
```

SendSensorCmd(SensorAddress, CmdLength, CmdByte)

```
XmitBuffer[0] = STX                // 1st byte is always an STX char//
XmitBuffer[1] = SensorAddress      // the Sensor Address//
XmitBuffer[2] = CmdLength
XmitBuffer[3] = CmdByte

If using CheckSum or error checking then
        Checksum = (STX + SensorAddress + CmdLength + CmdByte) * -1
        XmitBuffer[4] = Checksum        // put it at the end //
else
        for (i = 0; i < length[xmitBuffer]; i++)
        {
            ch = XmitBuffer[i]
            for (shifter = 0x80; shifter; shifter >>= 1)
                {
                        flag = (CRC & 0x8000)
                    CRC <<= 1
                    CRC |= ((shifter & ch) ? 1 : 0)
                    if (flag)
                     CRC ^= 0x1021
                 }
             }
         XmitBuffer[4] = CRC  (MSB)
        Xmitbuffer [5] = CRC  (LSB)

 Write(XmitBuffer, COMPORT)
 StartTimeOutTimer
```

ReadSensorRange

```
        //checksum //
MsgReceivedFlag = FALSE          // Initialize status flags//
FirstByteFlag = TRUE

WHILE ((NOT TimeOut) AND (MsgReceivedFlag = FALSE))
    IF ByteRcvd                                              // Got a byte ?//
       IF FirstByteFlag = TRUE                               // Yes! Is it the 1st one?//
          IF ByteIn = STX                                    // Yes! Is it an STX ?//
             BufferPtr = 0                                   // Yes! Start storing the packet//
             FirstByteFlag = FALSE
             RcvBuffer[BufferPtr] = ByteIn
             BufferPtr = BufferPtr + 1
          ENDIF
       ELSE                                // We've already got an STX so//
          RcvBuffer[BufferPtr] = ByteIn                      // add this byte to the queue//

          IF BufferPtr = 2                                   // Is this the Length byte?//
             RcvLength = ByteIn + 3                          // Calc how many bytes we'll get//

          BufferPtr = BufferPtr + 1        // Update our pointer//
       ENDIF
    ENDIF


    //CRC  ReadSensorRange //

                MsgReceivedFlag
                XmitBuffer[4] = CRC = FALSE

                WHILE ((NOT TimeOut) AND (MsgReceivedFlag <TRUE))
                        IF ByteRcvd
                                IF FirstByteFlag = TRUE
                                        IF ByteIn = STX
                                                FirtsByteFlag = TRUE
                                                BufferPtr = 0
                                                FirstByteFlag = FALSE
                                        RcvBuffer[BufferPtr] = ByteIn
                                                BufferPtr = BufferPtr + 1
                                ELSE
                                        RcvBuffer[BufferPtr] = ByteIn

                                        IF BufferPtr = 2
                                                RcvLength = ByteIn + 3

                                        BufferPtr = BufferPtr + 1

        IF BufferPtr > RcvLength        //* Got the Full Message ? *//
        StopTimeOutTimer                //* Yes! Stop the Timeout Timer *//
        MsgReceivedFlag = TRUE
                ENDWHILE

                IF MsgReceivedFlag = TRUE
                        RcvAddr = RcvBuffer[1]
                        RcvCmd = RcvBuffer[3]
                        RcvLen  = length[RcvBuffer] – 2
                        RcvCRC/Chksum = Last one or two bytes of RcvBuffer;
```



```
                    Calculate CRC or Checksum

                    IF RcvCRC/CheckSum <> CalcCRC/CheckSum
                            CRCError = TRUE
                        ELSE
                            IF RcvCmd <> CmdByte
                                CommandError = TRUE
                            ELSE
                            SensorRange = WORD(RcvBuffer[4])
                    ELSE
                        TimeOutError = TRUE
                        IF BufferPtr > RcvLength  // Got the Full Message ? //
               StopTimeOutTimer                      // Yes! Stop the Timeout Timer//
               MsgReceivedFlag = TRUE                // Set the status flag - We're done//
            ENDIF
        ENDWHILE

            IF MsgReceivedFlag = TRUE                // Packet received or Timeout ? //
               RcvChecksum = 0                       // Packet received. Then validate it//
               RcvAddr = RcvBuffer[1]
               RcvCmd = RcvBuffer[3]

               FOR loopctr = 0 TO RcvLength   // Calculate the checksum//
                  RcvChecksum = RcvChecksum + RcvBuffer[loopctr]

               IF RcvChecksum <> 0                   // Is it valid?//
                  ChecksumError = TRUE               // No! Indicate the error//
               ELSE
                  IF RcvCmd <> CmdByte        // Yes! Does the response match? //
                     CommandError = TRUE      // No! Indicate the error//
                  ELSE                               // Otherwise, get the range value//
                     SensorRange = WORD(RcvBuffer[4])
                  ENDIF
               ENDIF
            ELSE
               TimeOutError = TRUE     // Too much time passed//
            ENDIF
```

6.2 Reading Streaming Data

When sensor is in the stream mode it continuously sends out range values until host sends any character (byte) to the sensor to end the streaming mode.

To put sensor into the streaming mode, send command **134** using above described Packet Format

Sensor sends out 16 bit data of the following format:

MSB and LSB

7. Analog Output

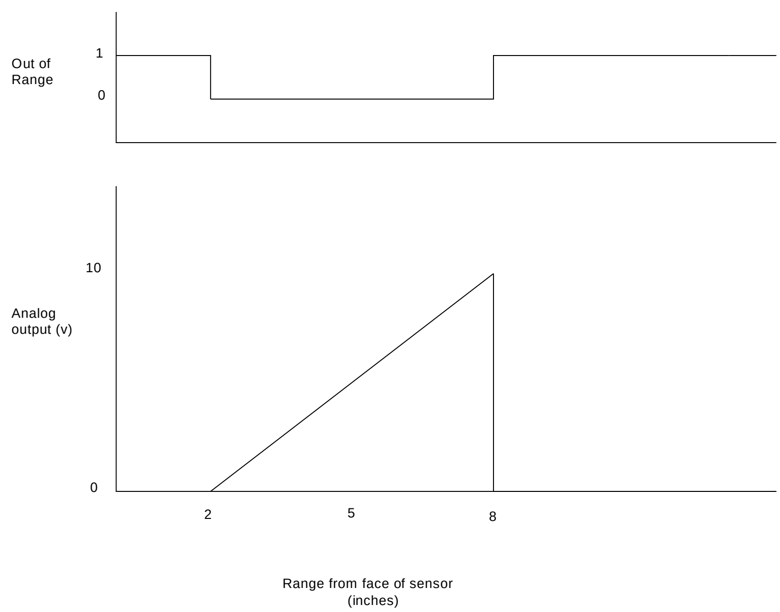
The sensor has an analog range output that starts at zero volts (at the standoff distance) and increases linearly to ten volts (at the maximum range). Outside the sensor's measurement range the voltage at this output is zero.

The output can source 2mA at ten volts. The internal impedance of the analog output is equivalent to 200 ohms. The output is protected against short circuits and is able to drive up to a 500pF capacitive load without oscillation.

The sensor also has an **out of range** indicator. It is a high low indicator. This is an open collector output. It is capable of sinking 5mA of current. When the signal is low the target is inside the measurement range of the sensor. When the signal is high, the target is outside the measurement range.

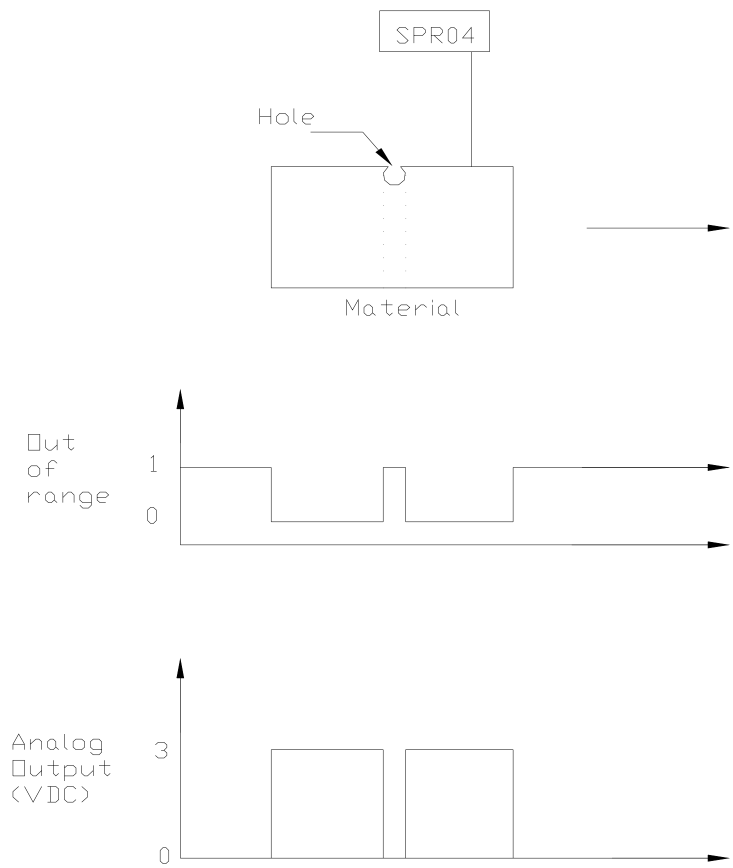
Note: Since zero volts can represent a target located at the standoff distance from the sensor and ranges outside the sensor's measurement range, the **out of range** signal should be used to indicate when a target is inside or outside the measurement range.

The **out of range** signal will respond within 0.53ms of the target moving into, or out of the measurement range. Refer to Figure below to see how the voltage and **out of range** output respond.



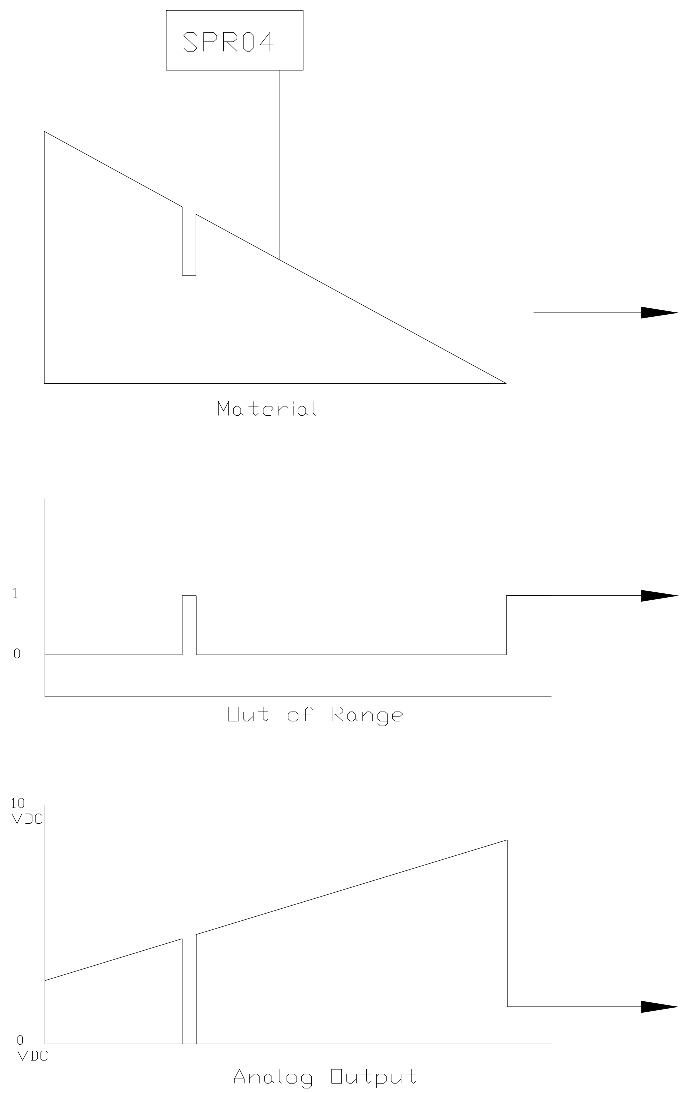
The following example of scanning a flat object with a hole shows the analog and the digital output out of range with the following settings

Min range	0”
Max range	8”
Volt@min range	0 VDC
Volt@max range	10 VDC
Volt@out of range	0 VDC



The following example of scanning an object of varying thickness with a hole shows the analog and digital out of range output with the following settings

Min range	0”
Max range	8”
Volt@min range	2VDC
Volt@max range	10VDC
Volt@out of range	0 VDC



8. Troubleshooting

This section will help you with any difficulties you may have in operating the SPR-04 sensor.

Before following the suggestions be sure that you have:

- a clean and regulated power source
- a calibrated voltage measurement device (DVM/Oscilloscope)
- a computer (optional)
- clean the camera and laser window glass on the sensor

8.1 Laser is off

Check to see if the power is turned on and providing 15 to 30VDC
Check cabling and ensure power is wired correctly.

No data comes from the sensor's serial port. (if using digital output)

1. Check cabling and ensure that power and signals are wired correctly. Make sure you have an RS-232 to RS-485 converter.
2. Check to see that the laser is on
3. Check to see that the camera's field of view is not obstructed, and that the window is clean.
4. Connect an LED with a 3.3K ohm resistor in series across Pins #5 - (Out of Range) and #1 (power).
5. Place a target within the sensor range. The LED should be lit.
6. Block the path between the camera and the laser. The LED should go out.
7. Check the analog output with an instrument capable of measuring DC voltage from 0 to 10 VDC (e.g. DVM).
8. Move the target back and forth. Observe the analog output. It should change as the target is moved. If the voltage changes it is likely that your serial port configuration and/or cabling is incorrect. If the voltage output does NOT change check your wiring again.

8.3 No data comes from sensor's analog output.

Check cabling and ensure that power and signals are wired correctly. For sensors with the digital interface option, make sure you have an RS-232 to RS-485 converter.

1. Check to see that the laser is on.
2. Check to see that the camera's field of view is not obstructed, and that the window is clean.
3. Connect an LED with a 3.3K ohm resistor in series across Pins #5 - (Out of Range) and #1 (power).
4. Place a target within the sensor's range. The LED should be lit.
5. Block the path between the camera and the laser. The LED should go out.
6. Connect the serial port of the sensor to a host computer using an RS-232 to RS-485 converter. Run the test program SPUTIL.EXE. Check the sensor's settings
7. Move the target back and forth. Observe the displayed range value on your computer. It should change as the target is moved. If the values change and there is still no analog output, the analog signals are probably incorrectly wired.

8.4 In a multi-drop configuration, one or more sensors do not respond and do not provide data to the serial interface.

1. Connect the offending sensor by itself (see previous) to see if it operates correctly in a non multi-drop environment.
2. If the sensor behaves correctly in Step #1, the problem may be that the sensor address is not unique, or it is set to 0.
3. Be sure you are using an RS-232 to RS-485 converter.
4. Check that the wiring of the multi-drop configuration is correct (See Serial Connections).
5. Check that the sensor addresses you are sending are correct. Use the utility program SPUTIL.EXE to reset any invalid sensor addresses.

8.5 Data appears erratic or jumpy

- Check for long runs of wire to sensor (excessive wire length can induce electronic noise).
- Check for unshielded wires to sensor.
- Check for 'voltage' or 'noise' generators near wiring to sensor.

8.6 Data is not as accurate as expected

- Check for sources of electronic noise (see above).
- Average data in head or in software.
- Make sure target is not highly reflective or black. Optical sensors require diffused light to reflect back to the sensor, too much or too little can cause sensor to be unable to read surfaces correctly.

9.0 MAINTENANCE

9.1 Preventative Maintenance Procedures

Since the DynaVision® scanner heads operate optically, the primary maintenance procedure is keeping the heads, and especially optical surfaces clean of sawdust, oil and pitch.

Do not immerse the unit in fluids or use a high pressure spray to clean.

The sensor contains optical and electronic components and under no circumstances should the enclosure be opened.

The following maintenance tasks should be preformed regularly to keep the scanner heads in good working order:

- Using clean air pressure system blow air over the laser and sensor glass surfaces to prevent dust particles from settling. It is important that the air be clean and free from oil and water.
- It is recommended that the face of the sensor be inspected and cleaned with isopropyl alcohol on a regular basis. Commercial glass cleaners should not be used; many have chemicals that leave a residue on the glass, which can affect optical performance.

10. Getting Further Help

If you wish further help on the SPR-04 contact your distributor.

For more information on Safety and Laser classifications, contact:

Center for Devices and Radiological Health, FDA
Office of Compliance (HFZ-305)
Attn: Electronic Product Reports
2098 Gaither Road
Rockville, Maryland 20850

10.1 List of Agents

10.1.1 Canada and the United States

Call our offices at 1-604-940-0141 for the agent nearest you, or visit our web site at www.lmint.com

International

EUROPE	LMI Selcom Inc. (Sweden) Box 250, S-433 25 Ogardesvagen 19 A Partille, Sweden	ph 46-31-336-25-10 fax 46-31-44-61-79